

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

### Claim Listing

1–16. (cancelled)

17. (new) A method of controlling a wind-up in the formation of a roll from a paper web having a strength, comprising the steps of:

a first step of: selecting a WOT (Wound-On-Tension) curve to be controlled to, using a selected starting WOT (Wound-On-Tension) curve, a model of roll stresses, a model of roll relaxation, and a model of runnability of a selected end use, by using the selected WOT (Wound-On-Tension) curve as an input to the model of roll stresses which produces an output which is used in the model of roll relaxation which produces an output forming the input of the model of runnability of a selected end use, and determining if the roll will be damaged in the selected end use, and if it is determined that the roll will be damaged in the selected end use, using a method for iteration to modify the selected WOT (Wound-On-Tension) curve, and then repeating the first step;

a second step of: selecting a winding recipe for forming a roll with the selected WOT (Wound-On-Tension) curve by using a selected starting recipe, and a model of the wind-up, using the selected starting recipe as an input to the model of the wind-up, using the output of the model of the wind-up in the model of roll stresses to define a model roll, and determining if the model roll formed by the selected starting recipe conforms to the WOT (Wound-On-Tension) curve of the first step within a selected accuracy; if the roll formed by the winding recipe does not conform to the WOT (Wound-On-Tension) curve of the first step within the selected accuracy, using a method for iteration to modify the selected starting recipe and repeat the second step;

winding the roll in the wind-up and measuring a WOT (Wound-On-Tension) curve;  
and

comparing the measured WOT (Wound-On-Tension) curve as a function of roll

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

diameter, or web length, with the selected WOT (Wound-On-Tension) curve and modifying the winding recipe so that the measured WOT (Wound-On-Tension) curve is the same as or within a set tolerance of the selected WOT (Wound-On-Tension) curve.

18. (new) The method of claim 17 wherein the second step includes constraining the winding recipe to limitations due to the mechanics of the wind-up and to the strength of the paper web.

19. (new) The method of claim 17 wherein the selected WOT (Wound-On-Tension) curve and the measured WOT (Wound-On-Tension) curve are curves of tension vs a function of roll diameter, or a function web length.

20. (new) The method of claim 19 wherein the function of roll diameter is a function of roll radius or the thickness of cumulated paper on a winding core.

21. (new) The method of claim 19 wherein the function of web length is a function of number of laps of paper on a winding core.

22. (new) The method of claim 17 wherein the method for iteration to modify the selected WOT (Wound-On-Tension) curve comprises a variation of the secant method.

23. (new) The method of claim 17 wherein the selected starting recipe is keeping nip load constant independent of the diameter for as long as possible, keeping winding force a constant independent of the diameter, and keeping web tension a constant independent of the diameter.

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

24. (new) The method of claim 17 wherein the winding recipe is determined as a function of the diameter or radius or the degree of thickness of the cumulated paper on the winding core or as a function of wound web length or the number of laps of the wound web.

25. (new) The method of claim 17 wherein the model of the wind-up is used to check that the roll will withstand winding in the wind-up.

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

26. (new) A method of controlling a wind-up in the formation of a roll from a paper web having a strength, comprising the steps of:

a first step of: selecting a WOT (Wound-On-Tension) curve to be controlled to, using a selected starting WOT (Wound-On-Tension) curve, a model of roll stresses, a model of roll relaxation, and a model of runnability of a selected end use, by using the selected WOT (Wound-On-Tension) curve as an input to the model of roll stresses which produces an output which is used in the model of roll relaxation which produces an output forming the input of the model of runnability of a selected end use, and determining if the roll will be damaged in the selected end use, and if it is determined that the roll will be damaged in the selected end use, using a method for iteration to modify the selected WOT (Wound-On-Tension) curve and then repeating the first step;

a second step of: selecting a winding recipe for forming a roll with the selected WOT (Wound-On-Tension) curve by using a selected starting recipe, and a model of the wind-up, using the selected starting recipe as an input to the model of the wind-up, using the output of the model of the wind-up in the model of roll stresses to define a model roll, and determining if the model roll formed by the selected starting recipe conforms to the WOT (Wound-On-Tension) curve of the first step within a selected accuracy; if the roll formed by the winding recipe does not conform to the WOT (Wound-On-Tension) curve of the first step within the selected accuracy, using a method for iteration to modify the selected starting recipe and repeat the second step;

winding the roll in the wind-up; and

controlling the wind-up, based on the winding recipe.

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

27. (new) The method of claim 26 wherein during winding the roll in the wind-up, a measured WOT (Wound-On-Tension) curve is monitored to determine whether the selected WOT curve is realized and, if necessary, the selected winding recipe is corrected such that a measured WOT (Wound-On-Tension) curve corresponds to the selected WOT (Wound-On-Tension) curve.

28. (new) The method of claim 26 wherein the iteration of the winding recipe is continued in a plurality of rolls formed in the wind-up.

29. (new) The method of claim 26 further comprising the steps of:  
indirectly measuring, in three or two dimensions, the internal stress distribution of the roll being wound up;  
calculating with the model the roll stresses caused by forces directed to the roll during winding;  
estimating the relaxation of the internal stresses of the roll after finishing before the roll is processed in the selected end use; and  
calculating with the model of runnability of a selected end use, stresses and displacements directed to the roll during unwinding.

30. (new) The method of claim 26 wherein the selected starting WOT (Wound-On-Tension) curve is based on starting data on the paper grade obtained through off- and on-line measurements of paper processing equipment preceding the wind-up and through measurements made in the wind-up.

31. (new) The method of claim 30 wherein limitations for the winding recipe are determined on the basis of basic data obtained through physical properties of the winding device and through the model of roll stresses.

Applicant: Pauli Koutonen et al.  
PCT App. No.: PCT/FI2003/000851

32. (new) The method of claim 26 further comprising the step of calculating, in the model of roll stresses, the model of roll relaxation, and the model of runnability of a selected end use, slippages or other damage mechanisms generated within the roll.